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GB 2262639 A **GB 2260627 A**

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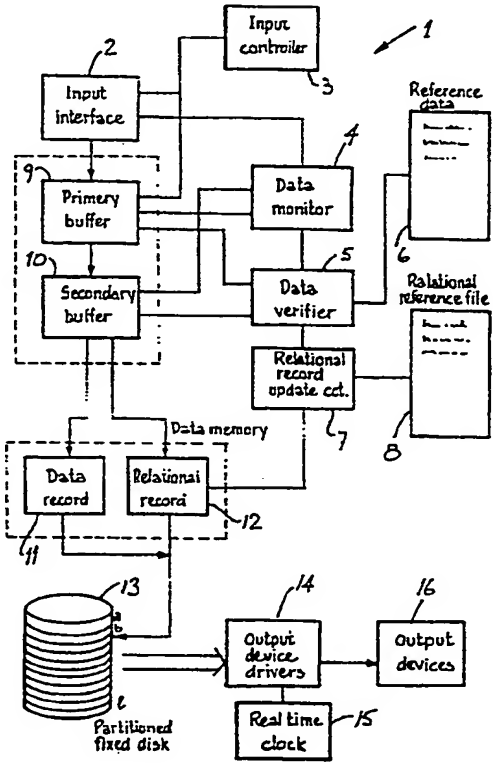
(54) Data verification in a process control system

(57) A process controller (1) includes an input interface (2) for reception of data. The interface (2) may be a serial port for receiving signals from sensors such as temperature sensors. Alternatively, it may simply be a keypad. A data monitor (4), a data verifier (5) and a relational record update circuit (7) ensure that all data whether relational or independent is automatically verified in an efficient manner to prevent writing of incorrect data to records (11) and (12). These records form the basis for the generation of output signals which may be time driven to initiate events for process control. Verifier 5 compares non-relational input data in buffer (9) against reference values from a file (6), and also checks at (10) whether complete sets of data have been entered.



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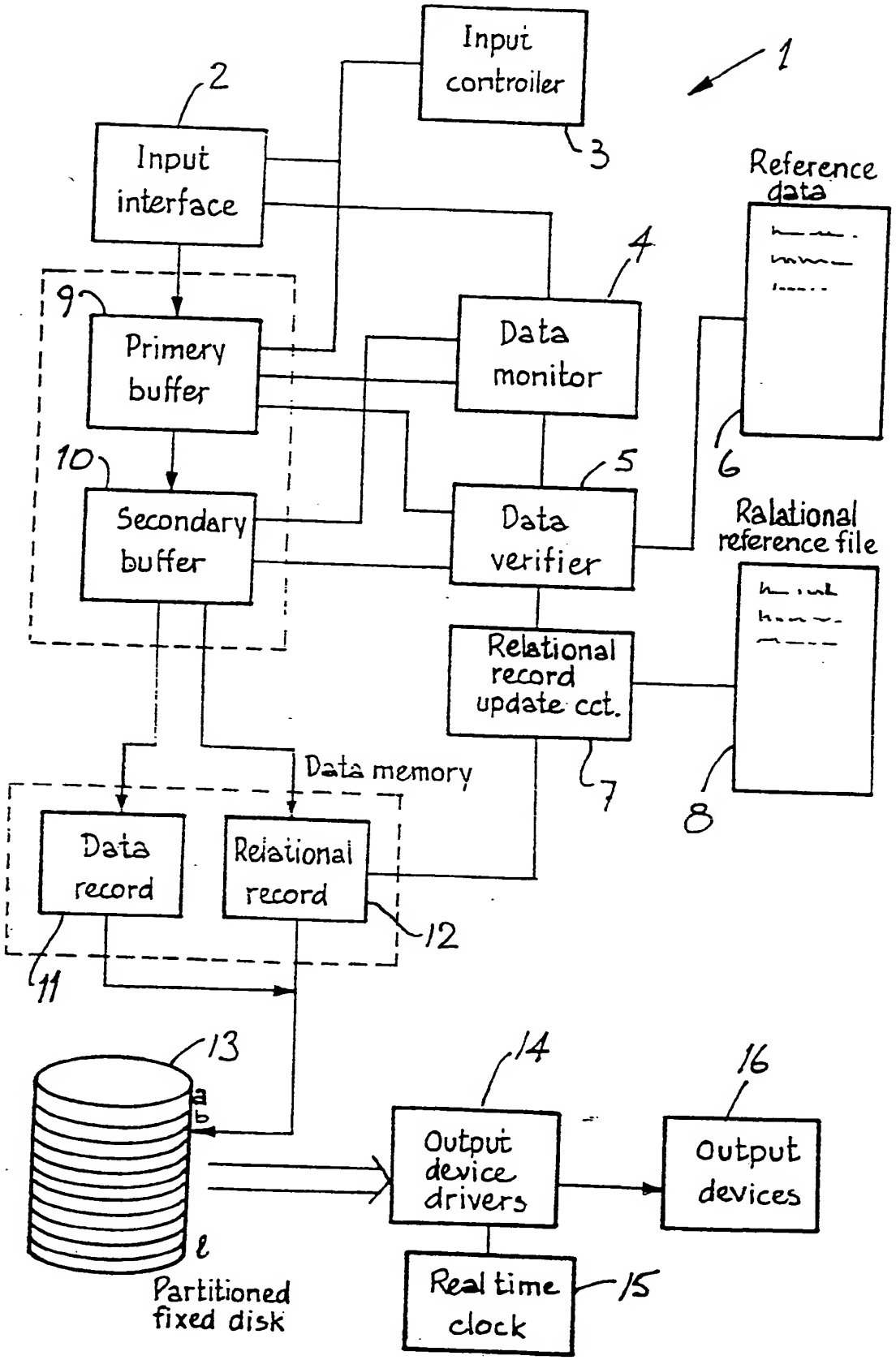

"Data Verification in a Process Control System"

The invention relates to process control systems.

The function of a process control system is to capture data and to output instructions or command signals which directly or indirectly control the carrying out of various process operations. In a manufacturing plant production line, a process controller outputs instructions for the automatic and semi-automatic production of products such as automobiles. In the office environment, a computerised process control system generates screen, printer and sound outputs which may indicate that work is to be carried out by certain deadline dates, and also generates the documents which are used in the process.

Irrespective of the nature of the process being controlled, it is absolutely essential that the process controller operates using correct data. One incorrect item of data may lead in a "chain reaction" to several incorrect items of data and to erroneous control signals being outputted. This can have disastrous consequences for the particular process. For example, in the office environment an incorrect deadline date for the compliance with formalities involved in the incorporation of a company can lead to major problems. In the chemical production field, an incorrect control signal relating to temperature could lead to a whole batch of a particular compound being wasted.

United States Patent Specification No. US 4,499,584 (U.S.A.) describes an apparatus for injecting spurious signals for incoming data at a recorder. The apparatus includes sensors and associated data channels. Data inputted on a data channel and not appearing on the blind channel enters the recorder without interruption. This

prior art illustrates the fact that quite an amount of work has been carried out in the manner in which data signals are handled and transmitted in an improved manner. However, if the data is incorrect to begin with no amount of spurious signal elimination will solve this problem. The simplest example is where an operator inputs wrong data into a data record of the process controller. Another example is where a wrong sensor is connected up to an input port of the controller in a chemical production plant.

British patent specification No. GB-B-2, 194, 655 discloses a system for capture of data in the form of analogue inputs. Several microprocessor units carry out operations on the received data. In many situations, it is not practical to operate in this manner as only one processor unit may be available because of the nature of the process control.

The invention is directed towards providing a data verification process carried out by a process controller to overcome these problems.

According to the invention, there is provided a data verification process comprising the steps of:

the input controller writing data received at an input interface to a primary buffer memory circuit and setting a flag in the memory circuit to an invalid status for each data item received;

a data monitor reading each inputted data item to detect if it is relational or non-relational;

for each non-relational item a data verifier comparing it with a set of reference values stored

in a reference file, changing the status flag to valid if verified and outputting an error message if invalid;

for each relational data item, the data verifier verifying the item and activating a relational record update circuit which in turn updates a related parameter value which is common to a plurality of records; and

the data verifier writing all of the data items for which the status flag is valid to a secondary buffer memory circuit;

the data monitor detecting if all of a set of data has been received and if so, directing display of an operator prompt for inputting of a data confirmation signal,

if a positive confirmation signal is received, the data verifier automatically transmitting the data from the secondary buffer to a data record,

if a negative confirmation signal is received, the data verifier re-setting the status flag of the data item to be amended, and carrying out the verification operations on the amended data item inputted and subsequently writing the data items to the data record after all flags are set to valid status;

the data monitor monitoring all amendment instructions inputted for detection of such an instruction for a relational data item,

on detection of such an instruction, the relational record update circuit re-setting the value of the linked parameter value and upon completion of data verification operations of the data verifier automatically retrieving all related or linked data items, and regenerating the parameter value; and

an output device driver generating process control commands using data retrieved from the data record and the relational record.

In one embodiment, the data record and the relational record are automatically written to a particular partitioned section of a fixed disk associated with the inputted data, the section being determined by the data monitor.

Preferably the reference values reference values are in the range of 1 to 3 bytes in size for fast verification and user interaction.

In another embodiment, the data monitor transmits instructions to a distributed processor for local data monitoring and verification.

In a still further embodiment, the process comprises the further steps of the output device driver repeatedly monitoring a real time clock and being activated when pre-set times associated with data records are reached,

the device driver when activated retrieving the data record associated with the time event and retrieving relational parameters associated with it; and
generating output process control signals according to the event.

The invention will be more clearly understood from the following description of some embodiments thereof, given by way of example only with reference to the accompanying drawing, which is a diagram showing the manner in which the process of the invention is carried out.

Referring to the drawing, there is illustrated a process controller and a data verification process carried out by it. The process controller may be for the control of a manufacturing process, or for the control of work carried out in an office in which the "end" product may be a process control instruction paper record.

As shown in the drawing, there is a process controller 1 which includes an input interface 2. Depending on the circumstances, this can be an input port for a microcomputer for connection to sensors, or in addition or alternatively it may be a keyboard or keypad. The input interface 2 is connected to an input controller 3. The process controller 1 also includes a data monitor circuit 4, and a data verifier 5 which is connected to a storage device storing a reference data file 6. There is a relational record update circuit 7 which is connected to a storage device storing a relational reference file 8.

The input interface 2 is connected to a primary buffer memory circuit 9, which is in turn connected to a secondary buffer memory circuit 10. The output of the buffer circuit 10 is connected to memory circuits for a data record 11 and for a relational-record 12. These are in turn connected to a fixed disk storage device 13 which is partitioned into eleven sections a, b, ... 1. The process controller 1 also includes an output device drivers 14 connected to a real time clock 15 and also connected for retrieval of data from the storage device 13. The drivers 14 drive output devices 16. In the

example described below, the output device drivers includes screen and printer controllers and the output devices 16 are video screens and printers. However, the output devices may be any particular process control output devices such as a robotic item of equipment on a production line.

The data verification process involves initially receiving data at the input interface 2 in response to prompts displayed at a video screen. However, a simple LCD display could be used instead. An important aspect of the data inputting process is that pre-defined reference values for data to be inputted are also displayed together with the prompts. In this embodiment the reference values are only 2 bytes long so that the display device is not cluttered and so that the operator may easily remember them. This also allows use of a small LCD where the controller is relatively small. Another advantage is that the verification operations may be carried out relatively quickly by the processors. The input controller 3 automatically writes the data to the primary buffer 9 and at the same time it sets a flag in the primary buffer 9 associated with each item of data to indicate verification status. The flag is initially set to an "invalid" status.

Subsequently, the data monitor 4 is activated and this reads each inputted data item to detect if it is relational or non-relational. The data monitor may be implemented by a set of instructions transmitted from a master controller to a slave controller which includes the input interface 2 for reception of the data. This allows distributed data verification in a complex process controller. The step above of the input controller directing display of data inputting fields applies only if the input interface is a keyboard. Where data is received via a link such as an RS232 link directly into a port of

the process controller, of course no such displays are involved. However, the inputted data must be configured according to the set of pre-defined reference values.

For each non-relational data item detected by the monitor 4, the data verifier 5 compares the data item with a set of reference values stored in the reference data file 6. This is a very simple set of operations which may be carried out in a relatively small number of processor cycles, as they involve direct comparisons between each data item in the primary buffer 9 with the reference values in the file 6. For each data item which complies with the reference values the status flag is set to "valid" status and the item is written to the secondary buffer memory circuit 10. If invalid, a signal is transmitted to an output device such as a file for later printing to indicate to an operator, or immediately to an output screen for a data processing system.

For each relational data item, the data verifier 5 verifies the item in the same way, but in addition it activates the relational record update circuit 7 which accesses the relational record 12 and updates a related data item. For example, where the inputted data relates to temperature at various parts of a liquid chemical bulk tank, the related data item in the record 12 may be the average temperature, which of course depends on the output from a number of different temperature sensors. Again, once verified and processed by the update circuit 7 each relational data item is written to the secondary buffer 10.

The data monitor 4 then reads the data in the secondary buffer 10 to determine if all of a set of data has been received. For example, there may be a required set of output signals from a particular sensor, or indeed a set

of data being inputted on a keyboard for a particular display panel. If all of a set of data has been detected by the monitor 4, it directs display of an operator prompt for inputting of a data confirmation signal. This operator interaction step has been found to be particularly important in ensuring that data which has been inputted from whatever source is correct. If a positive confirmation signal is inputted, the verifier 5 automatically transmits the data from the secondary buffer 10 to the data record 11. However, if a negative confirmation signal is inputted, the data verifier re-sets the status flag of the data item to be amended, and carries out the verification operations on the amended data item and subsequently writes the data item to the data-record after all the flags have been set to the valid status. It has been found that by re-setting the status flag stored in the primary buffer 9, links are established for operation by the verifier 5 in ensuring that all data has been verified in the correct manner. The set of status flags in the primary buffer 9 effectively track each data item to ensure that complete verification is carried out before writing to the data record 11.

On an on-going basis, the data monitor 4 monitors all amendments instructions which are received such as update signals from a sensor or keyed manual over-ride instructions for amendment of data items. When this happens, the data verifier operates as described above for verification. Where the data is relational, operation of the update circuit 7 is extremely important in these circumstances and the update circuit 7 re-sets the value of the linked parameter value in the related record 12. Upon completion of a data verification operation of the verifier 5, the circuit 7 automatically retrieves all related or linked data items and re-generates the parameter value in the relational record 12.

Operation of the output device drivers 14 is dependent entirely on the data which is in the records 11 and 12. The drivers 14 repeatedly poll a real-time clock 15 and become re-activated when pre-set times associated with data records are reached. The drivers 14 have pre-set events which are initiated according to real time and according to particular data records 11 and 12. These are of course retrieved from the storage device 13 after writing of the records 11 and 12 to the device 13. An important aspect of the invention is the manner in which output signals may be transmitted by the drivers 14 which incorporate both the data which has been inputted and the related data so that various different events may be linked for integrated process control.

It will be appreciated that the invention provides for the correct operation of a process controller by ensuring verification of data being received in an extremely simple and efficient manner.

The invention is not limited to the embodiments hereinbefore described, but may be varied in construction and detail.

CLAIMS:

1. A data verification process carried out by a process control system, the process comprising the steps of:

the input controller writing data received at an input interface to a primary buffer memory circuit and setting a flag in the memory circuit to an invalid status for each data item received;

a data monitor reading each inputted data item to detect if it is relational or non-relational;

for each non-relational item a data verifier comparing it with a set of reference values stored in a reference file, changing the status flag to valid if verified and outputting an error message if invalid;

for each relational data item, the data verifier verifying the item and activating a relational record update circuit which in turn updates a related parameter value which is common to a plurality of records; and

the data verifier writing all of the data items for which the status flag is valid to a secondary buffer memory circuit;

the data monitor detecting if all of a set of data has been received and if so, directing display of an operator prompt for inputting of a data confirmation signal,

if a positive confirmation signal is received, the data verifier automatically transmitting the data from the secondary buffer to a data record,

if a negative confirmation signal is received, the data verifier re-setting the status flag of the data item to be amended, and carrying out the verification operations on the amended data item inputted and subsequently writing the data items to the data record after all flags are set to valid status;

the data monitor monitoring all amendment instructions inputted for detection of such an instruction for a relational data item,

on detection of such an instruction, the relational record update circuit re-setting the value of the linked parameter value and upon completion of data verification operations of the data verifier automatically retrieving all related or linked data items, and regenerating the parameter value; and

an output device driver generating process control commands using data retrieved from the data record and the relational record.

2. A process as claimed in Claim 1, wherein the data record and the relational record are automatically written to a particular partitioned section of a fixed disk associated with the inputted data, the section being determined by the data monitor.

3. A process as claimed in Claims 1 or 2 wherein the reference values are in the range of 1 to 3 bytes in size for fast verification and user interaction.

4. A process as claimed in any of Clams 1 to 3 wherein the data monitor transmits instructions to a distributed processor for local data monitoring and verification.

5. A process as claimed in any preceding claim comprising the further steps of

the output device driver repeatedly monitoring a real time clock and being activated when pre-set times associated with data records are reached,

the device driver when activated retrieving the data record associated with the time event and retrieving relational parameters associated with it; and

generating output process control signals according to the event.

6. A process substantially as hereinbefore described with reference to and as illustrated in the accompanying drawing.

Patents Act 1977 Examiner's report to the Comptroller under Section 17 (Tl. Search report) -13-	Application number GB 9321859.2
Relevant Technical Fields (i) UK Cl (Ed.L) G4A (AEC,AEX) (ii) Int Cl (Ed.5) G06F 11/00	Search Examiner B G WESTERN
	Date of completion of Search 29 NOVEMBER 1993
Databases (see below) (i) UK Patent Office collections of GB, EP, WO and US patent specifications. (ii)	Documents considered relevant following a search in respect of Claims :- 1-6

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&: Member of the same patent family; corresponding document.

Category	Identity of document and relevant passages		Relevant to claim(s)
A	GB 2260627 A	(PETTIT) see whole document	
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